STATION CIRCULAR 108 MARCH 1934

# Walnut Production in Oregon

**A Revision of Station Circular 91**

WALNUT GROWING in Oregon is usually profitable if the planting is well located and the proper stock is used. ¶ There is sufficient suitable land in Oregon without using doubtful soils and locations. ¶ The trade is demanding clean, sound nuts, graded evenly, and carefully packed.

Agricultural Experiment Station, Oregon State Agricultural College, Corvallis

and

Bureau of Plant Industry, United States Department of Agriculture
Cooperating

## SUMMARY

Most of the walnuts in Oregon are grown in the Willamette Valley.

Walnut locations should be frost free with soil at least six feet deep, well drained, and fertile.

The Franquette is the best variety to plant.

Plant in late fall to early spring at distances of fifty to sixty feet.

Culture should aim to furnish the optimum amount of moisture and plant food. Commercial fertilizers should be tested out before being used on whole orchards.

After the scaffold branches are spaced, pruning is mainly thinning out.

Top-work the worthless seedling or variety. Some "sleepers" are doubtful for working over.

At frequent intervals pick up and wash the nuts. Dry quickly at a temperature of from 90° to 105° F.

Bleaching is now being used in this state.

Walnut orchards come into profitable bearing at nine to eleven years of age.

Insects are of little commercial importance as yet.

Walnut blight is common and does considerable damage in certain seasons. Control has been worked out for this disease.

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# Walnut Production in Oregon*

By

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## INTRODUCTION

THERE are no walnuts indigenous to Oregon. The early settlers on finding no walnuts in this part of the country planted some Eastern black walnuts that had been brought from the eastern part of the United States. Walnuts of the black type were also brought in from California and planted. A few of these old trees remain today. Associated with them are now to be found many trees of a hybrid nature resulting from cross-pollination between the Eastern and California species.

In the early days *Juglans regia,* commonly known as the English walnut though occasionally called the Persian walnut, was thought to be not adapted to Oregon conditions. A few of the trees resulting from nuts planted during the 60's and 70's demonstrated, however, that the English walnut will produce in this country and survive to good old age. The length of life of the English walnut is not known, but from comparative figures from other sections and a study of the few old trees in this part of the United States it is probable that well planted orchards should be still productive at the end of a century.

In 1897, Thomas Prince, of Dundee, Oregon, started his planting, which was the first commercial planting of English walnuts in Oregon. These trees were second generation or seedling trees. Until they became crowded from too close planting they were very productive.

Many of the early plantings were set out with little regard for the peculiar requirements of the English walnuts under Oregon conditions. The success and particularly the failures of these early plantings show us many things to avoid and questions to be considered as vital to the success of the future walnut plantings.

All of the earlier plantings were seedling trees, although apparently in the 80's a few grafted trees were shipped into the Northwest from California nurseries. With the introduction of the French varieties that leaf out later, walnut plantings increased in the Northwest. The success of these older plantings has recently stimulated further plantings of walnuts in Oregon.

## DISTRICTS FOR WALNUT GROWING IN OREGON

Most of the commercial plantings of Oregon walnuts are at present in the Willamette Valley. There are a few small plantings in the Umpqua and Rogue River valleys. In the other parts of the state commercial walnut growing must still be considered more or less an experiment. On account of the long time and cost necessary to bring a walnut planting into bearing, one can ill afford to put out a large acreage in those districts where walnut production is not thoroughly demonstrated as successful.

The coastal regions of Oregon have had little success with the walnut. The walnut, under humid conditions, is very susceptible to the bacterial

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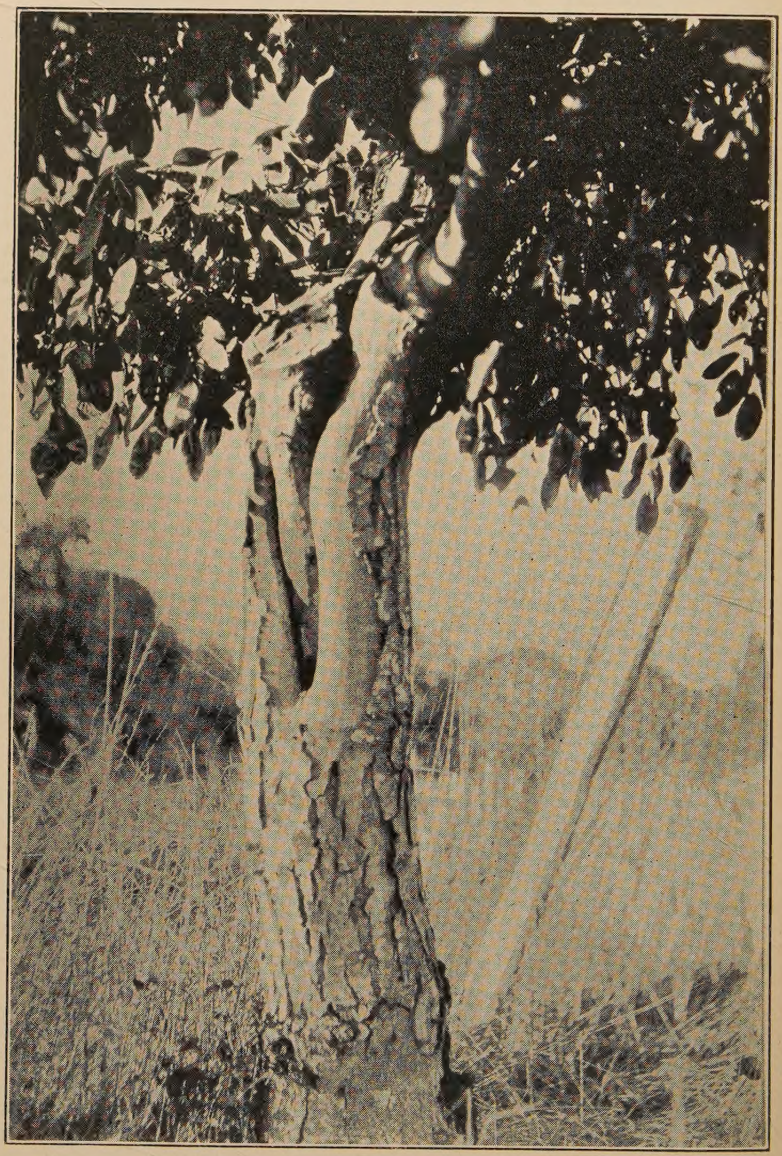

Figure 1. Walnut tree injured by cold temperatures. This type of injury has been common on low lands.

blight which affects both leaves and fruit. Some sheltered places can grow a few walnut trees for home use but seldom on a commercial scale.

East of the Cascade Mountains, walnut growing is generally limited by cold winter temperatures and spring and fall frosts. Only in a few places can walnut growing be considered on more than a home-orchard basis.

The breeding of walnuts is being carried on by a few men who are crossing the English walnut with the hardy species of walnuts in an endeavor to obtain frost-resistant varieties. Until such resistant varieties are available the growing of walnuts other than in well protected locations will not usually be practical in the higher, frostier parts of Oregon.

## TEMPERATURE REQUIREMENTS

The English walnut tree is sensitive to climatic conditions, a fact which deserves careful attention before a planting of this fruit is made. Successful growing of walnuts as related to temperature can best be treated under three heads: (1) low winter temperature, (2) spring and fall frosts, and (3) high summer temperature.

**Low winter temperature.** When fully dormant the tree is about as hardy as the peach tree, but complete dormancy of the tree seems to be rather rare in the usually mild climate of Oregon walnut-growing sections. The condition of the tree has apparently been as great a factor in winter damage as the temperature encountered (Figure 1). Four degrees above zero, Fahrenheit, has caused the trees to split open at times. This is also accompanied by killing of the catkins, fruit spurs, and twig growth to a greater or less degree. Lower temperatures have at times killed the trees outright (Figure 2).

Figure 2. Tree killed by cold temperatures. Trunk below snowline was uninjured at the time but is now dying back to the point of origin of the suckers. Note evidence of wood decay which often completes killing winter-injured trees.

A nut planting made on the Experiment Station grounds at Corvallis in 1912 included pecans, chestnuts, and walnuts. Many of the English walnuts were of the late-leafing-out, short-season varieties. During December, 1919, a cold spell occurred with a minimum temperature of –15° F., following comparatively warm weather. Practically all of the nut trees suffered damage, but the chestnuts and pecans showed more damage than the English walnuts. Among the English walnuts the short-seasoned varieties averaged less damage than the longer-growing

varieties. It was very noticeable, however, that the damage varied from tree to tree of the same variety almost as it did between varieties. The only variety to fruit the following year was the so-called Cut-leaved variety, the tree of which suffered no apparent damage from the cold weather.

**Spring and fall frosts.** The susceptibility of walnut foliage to late spring and early fall frosts is probably the greatest limiting factor to con-

Figure 3. Twelve-year-old tree on soil less than two feet deep.

sider in walnut growing. A frost in the spring after the foliage is out not only destroys the year's crop of nuts but kills back the current season's growth, acting as a dwarfing of the tree.

Frosts coming in the fall are especially injurious to young shoot growth, though they may also cause blank nuts or injury to kernels. The damage to the shoots is not readily noticeable until the following spring, when the shoots fail to leaf out. The frost kills the leaves before the shoots are well matured, keeping the shoots in a soft condition, and for that reason they dry out readily or die during the winter. Early fall frosts are undoubtedly the cause of much of the so-called winter injury. With young trees, especially those just set out in the spring, fall frosts may be so injurious as to kill the trees outright.

**High summer temperature.** Excessively high temperatures are of little importance in the district now growing walnuts commercially in Oregon. The chief injury to walnuts from high temperatures occurs on the fruit, causing sunburn, which may result in blank nuts, if it occurs early in the season, or in partly developed kernels and thin spots on the shells if it appears late in the summer. Temperatures exceeding 100° F. maintained for any length of time will cause the damage mentioned, or the dark-colored meats sometimes found, although dark meats are not always caused by high summer temperature. High summer temperatures must be considered in some places of the state where walnuts have not been thoroughly demonstrated as adaptable.

## SOIL REQUIREMENTS

**A minimum depth of five feet is needed.** The soil for walnuts should be not less than five to six feet deep. It is doubtful whether the better, more productive orchards are to be developed on soils five feet deep. This depth of soil is determined not strictly by the depth of the darker layer on the surface but by the occurrence of rock, hard-pan, water-table, or other substances impenetrable to the roots, or by a sand layer that will not hold moisture well throughout the summer.

The typical behavior of walnut trees on shallow soil is for the trees to thrive and grow well for the first few years and then to cease developing normally (Figure 3). This condition is usually followed by various forms of winter injury, or die-back, which prevent any increase in the size of the trees, and in many cases cause their death.

**Good drainage is important.** Walnut trees are intolerant of poorly drained soils, whether the excessive moisture is caused by seepage, as found on hillsides, or high water-table, as found in the flat lands of the Valley floor. Water-logged soils act on the roots as an impenetrable soil layer will do. Even if, during certain seasons, soil conditions allow root penetration to a greater depth, the rise of the water-table later will kill off those roots, resulting in a decreased root system that cannot fully supply the tree when the heavy demand for moisture for the top of the tree comes during the late summers of the following years. (Figure 4.)

**Fertility is necessary.** A tree as large as the walnut will require much plant food. Good fertility is necessary, and must either be present at the time of planting and maintained by good soil practices or must be incorporated into the soil later. Some types of soil with sufficient depth and drainage that are otherwise satisfactory are likely to be so located as to be subject to spring and fall frosts. Many sites suitable as to type of soil and location, moreover, have been farmed in such a way that fertility is at a low level. In cases where soils have been allowed to get in such condition a considerable amount of soil building will be necessary in order to bring the fertility back to the required condition for nuts.

Figure 4. "Winter killing" on tree planted on water-logged soil. Tree said to be more than twenty years old.

## ELEVATION

There must be good air drainage, unless local conditions prevent frost. Air drainage as a protection against frost is obtained by planting on a slope, with a clearance below so the air can drain away (Figure 5). An elevation of 50 to 100 feet above lower lying ground saved many orchards during the recent cold winters. Orchards so located escaped with little or no damage, while orchards on the lower grounds were seriously damaged. The injury varied with different locations, but in some cases resulted in the total killing of the tree.

During the winter of 1932-33, however, more damage occurred in the foot-hills than in the low-lying areas. This is one exception to the general rule, that more damage may occur on low-lying grounds than on the upper, higher lands.

The maximum elevation at which walnuts can be grown is yet in doubt, but it is probable that locations more than 1,200 feet above sea-level are not suitable for Willamette Valley conditions. Above that point, the growing season begins late in the spring and ceases early in the fall, so that the growing period is relatively short.

## WHAT SHALL BE PLANTED

**Desirable strains.** In discussing a variety of walnut, there is likely to be a discrepancy between the writers, especially concerning older varieties, or those imported from foreign countries. Coming from different sources,

various walnuts have been classed as the same variety, when it is evident that they are different. The numerous named strains of our older walnut varieties indicate the very mixed origin of the individual variety.

Figure 5. Rolling foot-hill land adapted to walnut plantings.

A comprehensive study and test of these strains or types is necessary to separate the good and bad types. If such a study is carried out, it may be possible to segregate several distinct varieties, producing good types of nuts of equal quality, but blooming and ripening at different times. No one variety known today is entirely satisfactory for Oregon conditions. The use of but one variety increases the chance of loss by adverse weather conditions at blooming time or at other critical periods.

Unless a nut is well sealed it cannot be shipped without breaking the shell, which destroys the quality of the pack. Light-colored meats are preferred to dark-colored meats. A nut containing a full kernel that fills out the shell well is more satisfactory than one with a kernel that only partly fills the shell. The quality and flavor of the kernel is one of the important points to consider.

Late leafing out of the tree avoids much of the rain and wet weather of the spring, when bacterial blight of the walnut is more serious, as infection increases with humidity. The varieties best suited to avoid this trouble are some French varieties like the Franquette, Meylan, or Mayette, though these are all more or less subject to this trouble.

**Second generation or seedling trees.** Seedling walnut orchards have been and are profitable, both in this state and in California.

Seedling walnut trees do not produce nuts that are exactly true to the type of nut produced by the parent tree. If the crop of nuts from a vigorous tree producing large, long-shaped nuts be planted, some of the resulting trees will be as vigorous as the parent tree, and others will have a slow growth with poor production. Some will produce large, long nuts, but just

as many are likely to produce large or small, round nuts. A large enough percentage of the trees may be sufficiently satisfactory to make the planting profitable, but there is no assurance that every seedling planting will pay. Setting any lot of seedlings from single or mixed parentage and observing the results will bear out the fact that uniformity is lacking, and that the walnut does not run contrary to the rules of genetics. There is no single tree or variety known that will produce a progeny true to its type. This is contrary to claims made for certain seedlings but is borne out by field inspection.

## VARIETIES OF WALNUTS

In the discussion of varieties the main ones are listed in order of commercial importance and general favor with which they are considered by the growers of the state.

**Franquette.** This is a French variety said to be nearly 200 years old. It was first introduced into California by Felix Gillet in 1871. A later planting was made on the Vrooman estate at Santa Rosa, California, this being an independent importation from that of Felix Gillet, so that the strain is commonly known as the Vrooman Franquette.

This variety, which is the leading commercial variety of Oregon, has many advantages as well as some disadvantages. It leafs out and blooms late in the spring, thus escaping much of the long period during which infestation from walnut blight could take place. The crops are fairly regular and heavy, with attractive nuts. The kernel is of light color, of excellent quality, and fills the shell. The shell is tightly sealed and stands handling well. The nut is of the long type.

Young Franquette walnut trees are often shy bearers of catkins and frequently produce these male catkins so early in the season in comparison with the production of the pistillate flowers that pollination is impossible.

Several types of Franquettes have been found but are not clearly recognized. Among these are the Selected Franquette, Improved Franquette, Wheeler Franquette, Mayquette, Knapp, and others. None of these have as yet been thoroughly tested and demonstrated as being successful, but they are being tried out as to their adaptability in certain sections.

**Mayette.** This is a French variety corresponding in vegetative habits to the Franquette. The quality of the kernel is excellent, but the variety has the failing of not being as resistant to drought as the other varieties. During dry seasons the Mayette is likely to show a high percentage of poorly filled nuts. It often weighs out light in comparison to the bulk, for it has a large, light shell, with a kernel that does not fill the shell as fully as other varieties. The sealing is not as strong as it should be, hence the Mayette is not adapted to shipping in sacks. The nut is of the general round type. Several strains of the Mayette are known but not generally grown.

**Meylan.** This is a French variety of excellent quality that has given erratic results in this state. Its worst characteristic seems to be light cropping, though by some growers it is reported as a heavy bearer. Aside

from this it seems to be an excellent variety, as it has an attractive appearance, is well sealed, and has a kernel of good color that fills the shell fairly well. It deserves additional investigation and trials in this state as a possible future variety.

**Wiltz.** The Wiltz, or Wiltz Mayette, is somewhat larger than the Mayette itself, but thinner shelled and more poorly sealed. The quality is excellent, but owing to the thin shell and poor sealing it cannot be shipped in bags. The tree and productivity of the variety have no superior qualities over the other standard varieties.

**Parisienne.** It is an old French variety, with tree vigorous and hardy. The nut is medium in size; the kernel is of good quality. It has never reached commercial importance, although grown occasionally with good results. By one or two growers who have this variety it is considered hardier than the other French varieties commonly grown in this state.

**Miscellaneous varieties.** Since there are many minor or little-known varieties about which inquiries are occasionally made, these varieties will be briefly mentioned.

CHABERTE is an old French variety. The tree is hardy but a shy bearer while the nut is small though of good quality.

COLUMBUS is a seedling introduced by Felix Gillet. The nut is large, smooth, roundish-oblong, and attractive in appearance. The quality of the kernel is good and it fills the shell fairly well. The tree as grown in this state is small, almost a dwarf in growth habit, and not a very heavy bearer. This characteristic of a small tree with only a comparatively small crop eliminates it from commercial production.

CLUSTER. An occasional tree of this is found. The nuts are borne in clusters, are of small size, though of good quality, and are borne in fair amounts on the tree.

CUT-LEAVED. Probably one of the Laciniata of various writers. The trees are drooping in habit, with a finely cut leaf, and produce a small, long nut. In the variety planting on the Oregon Agricultural Experiment Station grounds a tree with this name was the only one to bear after the freeze in 1919. The tree apparently suffered no damage from the severe weather.

PRAEPARTURIENS. This is an old French variety supposed to be comparatively hardy and very precocious in its bearing. The nuts are medium to small, with no great quality in either the nut or tree to recommend the variety. Seldom found.

MAMMOTH WALNUTS. This is taken as a type name, embracing a group of very large nuts. These uniformly have a very large shell, either thick or thin, and generally with a small kernel in comparison to the size of the shell. Most of these varieties are light in production and are of value only for the size of the shell. In this group are the Bijou, Gant, Ford, Mammoth, Wilson, Glady, and other similar varieties.

WEEPING WALNUTS. There is found occasionally an example of a weeping or drooping walnut. It is of no importance except as an example of the unusual freak or type occasionally found in seedling walnuts. These are very rare and only grown as a curiosity in the dooryard.

Of the varieties generally grown in California, such as the Placentia, Ehrhardt, Payne, Concord, and Eureka, none prove successful in Oregon. The Eureka, which is one of California's later blooming varieties, has been found too much subject to blight in this state. This is to be expected as it blooms much earlier than the Franquette. The other varieties are also fairly early or very early in blooming, so that they are not adapted to the short growing season of this state.

## BLACK WALNUTS

Practically all the black walnuts grown in Oregon are seedlings and generally of the Eastern black walnut. In the last few years, a limited number of trees of the grafted kinds, such as Thomas and Stabler, have been planted by lovers of the Eastern black walnut. As yet there is nothing to show that growing these walnuts for the cracked meats will be a profitable proposition as compared to the growing of English walnuts.

Growing the black walnut for timber has been recommended by some but must be fitted in with a reforestation and not with a nut-production program. There is no question that the trees will grow well here.

## POLLINATION

Walnuts often shed the pollen at times that do not correspond to the maturity of the female flower. So far as is known, the pollen of any species or variety will pollinate the pistils of that variety if the pollen is available at the proper time for the pistils.

The Franquette commonly sheds most of its pollen before the pistils are fully developed. In some seasons and under certain conditions the time between the shedding of the pollen and the maturity of the pistils is such that small crops result. This seems to be more likely while the trees are still young, but even with old trees it is quite pronounced in some seasons.

In many orchards, in order to furnish pollen later in the blooming season, other varieties are being grafted in which shed the pollen after the Franquette has practically dropped all the catkins. Of the old, established varieties, one type of late blooming Meylan has proved satisfactory. In addition, numerous seedlings that produce pollen at the proper time are, or may be, used for this purpose. In experimental work pollination from black walnuts has never measured up to that from the Meylan or seedling walnut.

While intersterility may be rare, it is wisest to be sure that any variety or kind introduced as a pollenizer will pollinate the Franquette. The Franquette variety constitutes most of the acreage. In Mayette orchards the same trouble sometimes occurs, and apparently can be corrected by the same methods, but the varieties or seedling introduced must coincide with the blooming habits of the Mayette and not with those of the Franquette.

## PROPAGATION

**Choice of rootstock.** In propagation of walnuts by budding and grafting, various species of walnuts have been tried as rootstock. In earlier days the Southern California black walnut (*Juglans californica* Walt.) was used, but later was discarded as it was subject to root rots and also tended to sucker profusely.

The eastern black walnut (*Juglans nigra* Linn.) was used to a certain extent but its slower growth made it unsatisfactory for commercial walnut orchards. Nurserymen propagating black walnut varieties such as the Stabler, Thomas, or other varieties usually use eastern black walnuts for rootstocks.

The Northern California black walnut (*Juglans hindsi* Sar.) has been used most extensively as a rootstock and until recently was considered entirely satisfactory. It has a vigorous growth and only very occasionally is attacked by mushroom root rot or other root rots and seldom suckers to any extent.

A serious trouble with this latter species has lately developed. A few trees have been dying due to a girdling that occurs at the graft union. The growth may be satisfactory for twenty or more years, when the union between the rootstock and top suddenly ceases and a complete separation of the two kinds of tissues results. In cases where identification was possible, it seemed that these rootstocks were not true to the species, but were of hybrid origin. In one orchard where the origin of the stock could be traced, that part of the orchard on seedling roots grown from nuts from a hybrid tree showed greater loss than that part of the orchard grown on rootstocks that originated from a tree apparently of pure blood, *Juglans hindsi*. In nurseries propagating walnuts a greater or less number of hybrids is always to be found among the seedlings used for grafting. From the small amount of information available at present, it seems best to eliminate these supposed hybrids and graft only those that are apparently pure *Juglans hindsi*.

Some growers are resorting to the use of Franquette seedlings as stock on which to graft. While these may form a congenial, lasting union, their use opens a possibility for mushroom root-rot infections, as seedlings of this type are very susceptible to such infection. The old seedling walnut orchards were invariably planted on land cultivated for many years where this fungus was not apt to be present, so little loss was occasioned in our commercial seedling orchards from this cause. In some cases where plantings were made on newly cleared land, however, the loss of seedling walnut trees has been serious.

Unless the soil is known to be free from mushroom root-rot fungus, the Northern California black walnut is still the best rootstock to be used, even though some loss by its use in the future may be certain.

*Juglans rupestris* Engelin and *Juglans major* Heller are both small-growing species without size enough to warrant their use as rootstocks. *Juglans sieboldiana* Maxim and *Juglans sieboldiana* var. *cordiformis* Makino have been found very difficult to graft on to under local conditions. The hardiness attributed to

them has not been sufficiently demonstrated to justify attempts to use them. *Juglans cinerea* Linn. has not been tried enough to afford any information.

**Grafting and budding.** All the walnut varieties in Oregon are propagated by grafting. Budding has never been successfully carried on over a period of years. Occasionally there will be a fair set of buds in a nursery.

Under local conditions the black walnut seedlings are usually two years old when grafted. If the graft takes that year it makes a three-year-old root with a one-year-old top after one year in the nursery. Seedlings of that age form a large root with a very large cut where grafted. Especially is there a large cut surface when the seedlings must be regrafted after failure the first time. Undoubtedly much of the prejudice against grafted trees comes from heart-rot that may enter the large cut or crevices before the wounds are grown over. Observation of nursery stock sent out at times gives the impression that trouble will be had later in the life of the tree from heart-rot which may develop at the point of union of the stock and scion. Nursery trees have at times been found with decayed wood at the point of grafting, which is detrimental in the development of the tree later on.

The attempt of many people to grow their own nursery trees is a doubtful proposition from a practical standpoint, owing to the cost of the trees. With a low average percentage of young trees raised over a period of years by the professional nurserymen it would seem inadvisable for the person inexperienced in grafting to attempt to raise the trees instead of buying them from the nurserymen. When it is considered that so few walnut trees are planted per acre as compared to the number of other fruit trees usually set out, the actual cost per acre for planting walnuts is hardly any higher than that of other fruits.

**Plant large-sized trees.** Large trees should be planted if the studies made with other fruits are to be applied to walnuts. Experience has shown that the large tree in the nursery makes the large tree in the field. This large size is caused by the extra vigor of the seedling root, which is able to furnish larger amounts of plant food for the top. The large, vigorous trees are predominantly the heavy bearers in the orchard. With trees of the same age grafted on to roots of the same age and grown under identical conditions, the larger trees are to be chosen in preference to the smaller ones even though the initial cost is greater. These should not be confused with the larger trees developing the same season which have been grafted on to older roots. A large tree from a three-year-old root is of no greater value than a medium-sized tree on a two-year-old root. The distinction should be made between those of the same age, grown on the same aged roots and under identical conditions. Trees should be avoided that have coarse soft wood caused by overforcing either from irrigation or extra rich soil.

**Planting the nuts in a permanent place.** Many are advocating planting the black walnut nuts in the field where the trees are to grow. Everything taken into consideration, however, there seems to be little reason for developing an orchard in that way. In this practice three or four nuts are planted in a hill at the spot where the trees are desired to grow permanently. As soon as well started, the weakest trees are pulled out and the strongest, most vigorous tree is left.

One argument in favor of this method is to avoid disturbing the tap-root. In transplanting the trees the tap-root is cut. This is claimed by some to prevent the tree from reaching the ultimate depth of the soil and obtaining the greatest supply of moisture. Very few soils are so deep that the lateral roots of the walnut will not reach the rock below. It is known that the lateral roots will readily penetrate soil that is six feet deep or deeper. The greatest difficulty is actually to find soil that is six feet deep or deeper, enabling the walnut root to penetrate to that depth. Even when cut, the tap-root may continue its downward course, often breaking into two or three parts at the place where cut off.

The supposed hardiness of the black walnut trunk in its resistance to injury is another argument. Probably the bark of the black walnut is more resistant to mechanical injury. After recent cold spells when the temperature was from –8° F. to +3° F., it was found that the Northern California black walnuts showed more discoloration of the inner bark and more actual killing than the English walnut trees of the same age and the same planting. Lifting of the bark was also more evident on the black walnuts. This may not hold for all seasons, but it goes to show that the arguments for the greater hardiness of the black walnut cannot be depended on at all times.

Figure 6. Top-working black walnut tree where the nut had been planted in the place the tree was to grow.

There are several ways of top grafting the black walnut in the field. One way is to cut the trunk off at a height of from two to five feet (Figure 6), inserting one or two scions, according to the size of the trunk at that point, and building the top from the best growing scion. Others advocate grafting on the scaffold limbs a certain distance from the trunk. Either method is costly in the end and takes longer to bring the walnut orchard into bearing than if grafted nursery trees are used. If it were possible to graft over the trees and get approximately 100 per cent of the scions to grow, it would seem feasible, but when it is known that the average is much below this figure and that it takes two to four years to finish grafting over a planting, the time factor is considerable. Trees can be more easily and more cheaply cared for in the nursery rows than when scattered at intervals of 50 to 60 feet apart over a large field.

## SETTING AN ORCHARD

**Early planting.** The planting season extends from fall to early spring. Under Western Oregon conditions, where the walnut is chiefly grown, the roots of fruit trees develop throughout the winter season. The climate is so mild that only occasionally is root growth stopped by cold temperatures. With the large root system developed by the tree in the nursery, it is impossible to move more than a small part of the roots when transplanting. The earlier in the planting season the tree is set in the field permanently, the better chance will the tree have of replacing a part of the lost root system. The later in the spring the planting is made, the less the chance of developing a partial root system that can cope with the summer's demands. Walnut trees are often slow in starting the first year or two under the best of conditions, so that an added handicap of late planting should not be imposed if it can be avoided.

**Allowing the tree plenty of space.** A distance of 50 to 60 feet is recommended. If the trees are planted 40 to 45 feet apart, it is with the idea of thinning out very soon after the trees begin to bear (Figure 7). Taking out vigorous bearing trees is a painful operation to most people and is usually postponed until the permanent trees have received a decided setback. According to statistics from California, the older, more mature orchards with a planting distance of 60 feet are among the most profitable orchards in the state.

Figure 7. Old orchard badly crowded. Note bearing surface on outer ends of upper limbs.

When planting a walnut tree, it must be remembered that a tree is being set out which under normal conditions will continue to increase in size during the lifetime of the average man. Maximum crops can be expected only from those trees that can grow freely, unhampered by closely adjoining trees. Extreme distances that might be ideal can not be furnished the trees under cultivated conditions, as too little returns from the land

would be received during the first years of the planting. On the other hand, the walnut has a much greater size when it begins to bear than have other fruit trees, thus needing a greater initial space. Walnut trees are naturally large and cannot be kept small if they are to return good crops.

**Laying out an orchard.** Orchards can be laid out on the square or hexagonal system. The first step is to lay out base-lines, with two or more base-lines for the square system and one for the hexagonal system.

For the square system take one side of the field from which a line can be laid off parallel to the fence or road, such as the base-line AB (Figure 8). With a tape or other measure lay out 60 feet on this line AB. Then on the line AC approximately at right-angles to base-line AB, lay off 80 feet, striking an arc and using A as a pivot point. From point B with a line 100 feet long strike another arc. Where the arc of AD and BD intersect will be the point through which the line AC may be located permanently and at right-angles to the base-line AB.

It is generally of advantage to lay off another base-line at the opposite point of the field from A on the base-line AB.

As equipment in laying off by the square system, or by the hexagonal system, a set of wires should be provided the same length as the distance apart that the trees will be set out. These are two wires with one end of

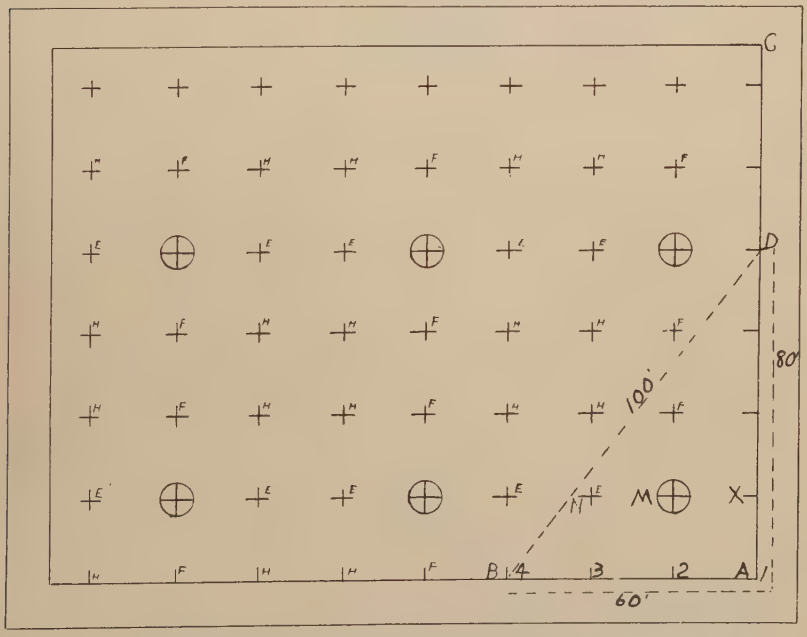


Figure 8. Laying out an orchard by the square system.
⊕ Walnut trees. + Filler trees. In thinning it is suggested that those marked "E" be taken the first year, those marked "F" be taken next, and those marked "H" the last removed.

each joined together in a small ring and the free ends fastened to separate rings. After staking off the base-line by measuring at desired intervals for the tree, begin staking the tract with wires. Placing the free rings over stake 2 and stake X, and drawing the wires taut, locate a stake at point M (Figure 8). Then move the wires over so that the ring can be placed over stake M and stake 3; a stake can then be placed at the center ring at point N. This process can be carried on indefinitely, backward and forward across the field, until the field is completely staked out. The wires should be held in the same plane and drawn up to the same degree of tautness. Occasional checking by sighting or by remeasuring the wires will be necessary to straighten out the rows, especially if the field is uneven.

For the triangular or hexagonal system one base-line only is needed, spaced at the regular intervals for the planting of the trees. Placing the rings over stakes 1 and 2 (Figure 9), the wires are drawn tight and a stake

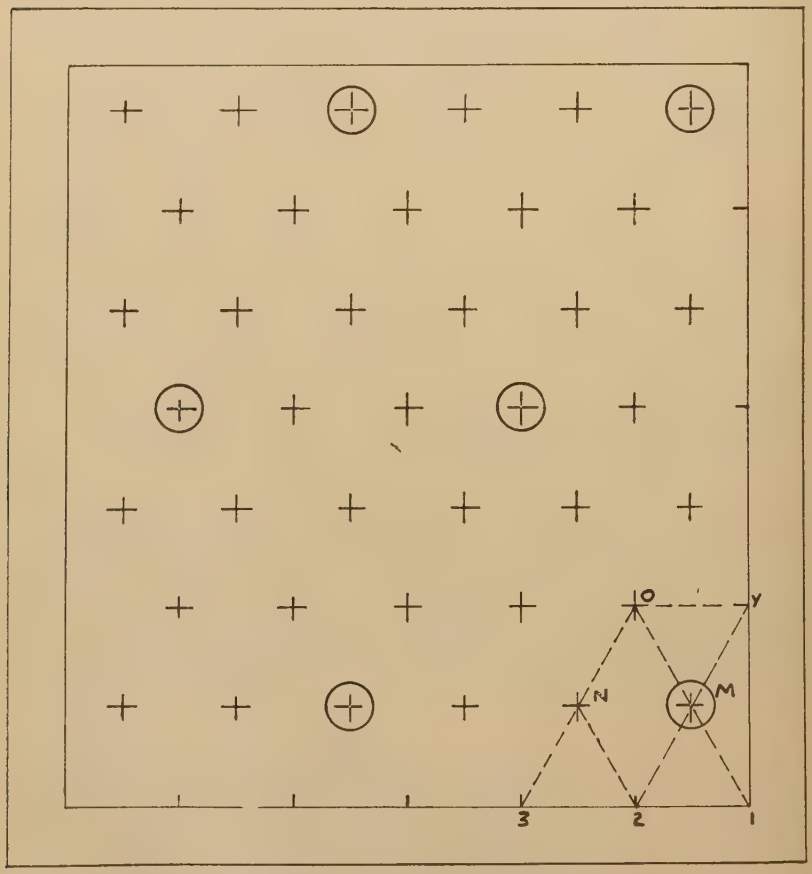


Figure 9. Laying out an orchard by the hexagonal system.
⊕ Walnut trees. + Filler trees.

is set at M. Then move over until the rings are over stakes 2 and 3; the stake is then placed at N and so on throughout the field. In using this method the rows will each time become shorter so that it will be necessary to fill out the side of the field. By placing one free ring over M in the second row and O in the third row, as illustrated, a stake can be placed at Y so that the third row will be lengthened out to the normal length.

A long wire with soldered points on it indicating the points at which stakes are to be set is often used on level land.

Other methods of staking out can be used, such as the use of transit or by sighting from two sides of the field with a man to set the stakes at the points desired. On the whole it will probably be found that the use of wire is the quickest and simplest method that can be employed for land not too uneven.

**Is blasting the soil advisable?** Blasting is unnecessary with the soil of the requisite depth and texture, and is of no particular advantage. Soils that may be benefited by blasting should be looked on as a doubtful class of soils for walnut growing. The effect of blasting on the usual subsoil in this country can only be temporary, as within a short time the subsoil will have run together again. Where blasting was used, observations in orchards have shown that the effect on the growth of the trees was not enough to warrant the expense of the powder.

Blasting with the idea of shattering the soil can be carried on only when the soil is dry. If done when the soil is wet, or damp, the soil is not shattered but merely packed more tightly away from the center of explosion. If the powder is put down four feet deep, as it should be for walnuts, the soil is likely to be much more moist than on the top, and packing at any time of the year may result from the blasting.

**Care in setting.** Larger holes are needed for walnut trees than for other fruit trees as the root system is usually much greater in extent. If fresh top soil is worked in around the roots at the time of setting it will be better than the lower soil. The top soil is richer and better suited for root growth due to the fact that it is usually freer and of more open texture. Work the top soil carefully and tightly around the roots so that air pockets will be avoided where the roots might dry out.

Although it is urged to plant early, the trees should not be planted when the soil is too wet to work well, as the soil in this condition cannot be thoroughly packed around the roots, with the result that air pockets are left; or if the soil is stamped or packed firmly it becomes so puddled that it retards root growth of the tree.

**A planting board is necessary.** Unless a planting board is used, it will be very difficult to set the tree accurately, owing to the large hole necessary to be dug for the walnut tree. The planting board is a board three to four feet long with a notch cut at each end and one in the center. The tip of the notch in the center and those at the ends should be in line to insure accuracy. Before digging the hole, place the board with the center notch against the stake where the tree is to be set. Then place a stake temporarily at each end of the board, so that the center stake and board can be removed. After the hole has been dug and when ready to set the tree, place the board in contact with the two temporary stakes. With

the tree held against the center notch, the alignment of the planting can be maintained.

**Roots need protection while being transplanted.** Protect the roots against drying out as much as possible when transferring the trees to the field. The roots may be covered with wet burlap or similar material or placed in a barrel of water. The large roots of the walnut tree are apparently not as susceptible to damage from drying out as are the smaller roots of some other trees, but the greater the care taken in protecting the roots, the better the tree will respond.

**Intercropping.** On account of the length of time it takes a walnut grove to come into bearing, few people are financially able to develop such planting without income from the land in the meantime. With the great distance apart the trees are planted, much of the land will lie idle for years unless interplantings of some kind are used.

Several different kinds of fruit crops have been used for interplanting. Of these possibly cherries have been the least satisfactory, owing to the large growth, while prunes have proved the most satisfactory. With the interest in nut planting, filberts have been suggested. Filberts are just as long lived as walnuts, and gradually increase in size and bearing over a long period, hence are far from being an ideal filler tree. The ideal filler bears early and makes only a small-sized tree.

With fillers interplanted among the walnuts, the growth and bearing of the walnuts will probably be retarded to a certain extent, but the income derived from the intercrop should greatly overbalance this slight loss. As the filler trees begin to crowd the walnut trees they may gradually be removed. It is better to remove those that first compete with the walnuts than to allow all the fillers to remain for a longer period of time and then pull them all out at the same time. The balance of income derived from walnuts and fillers will in that way be better maintained.

Small fruits may be used also, but with trellises, which are usually necessary, the cost of cultivation will be increased, as cultivation can be carried on in one direction only. Small fruits readily adapt themselves to this use. The rows next to the walnut trees may be removed as they encroach on the walnut trees, and thus the intercrop gradually reduced to suit the demands of the walnut trees.

*Use annual cultivated crops for intercropping where possible.* With these the soil can be kept in best condition, a greater use of the land can be made when the trees are young, and the area devoted to intercrops can be more easily adjusted each year to the needs of the walnut trees.

Grains and hay are the least satisfactory intercrops, but can be used if sufficient cultivated space is allowed the trees. In calculating the space for cultivation around the trees, increase by one-half that which it is estimated the top will extend over at the end of the season's growth. This is to avoid competition between roots of the walnut and the intercrop.

A satisfactory fertilization program should accompany the intercrops. Continued cropping of the soil will so decrease fertility that the walnuts will be unable to make the growth desired. None but the very richest of our soils will be able to stand such a practice without injuring the walnut trees.

## CULTURE

**The walnut tree needs plenty of moisture.** Although the fruit of the walnut is a hard-shelled nut, the size of the shell and the filling of the kernels to a great extent depend on the moisture supply from the soil. As the walnut orchards of Oregon have become older and the trees larger, the demand for moisture in some soils and in certain seasons has become so great as to bring about a shortage. Shriveling of the kernels has frequently resulted to such an extent, at times, that whole crops have been nothing but cracking stock.

Cultivation is a method used to conserve the moisture, but no known means of cultivation can bring back moisture once lost or furnish to the trees more moisture than can be stored in the soils. The object of cultivation is to limit as much as possible the escape of moisture through other channels than the walnut trees. Cultivation aims to avoid the loss of moisture through evaporation direct from the soil or transpiration from vegetation other than walnut trees.

To be most effective cultivation should begin early, wherever possible not later than the first part of April. Delaying later than this will in many seasons allow cover crops or other vegetation to remove more moisture from the soil than is replaced by rains during the time of delay. Allowing cover crops to attain a large growth often necessitates keeping them growing after the heavy rains are over, thus removing moisture that should be left for the trees. Whenever spring vegetation other than walnut trees removes more moisture than is replaced by rainfall, irreparable damage to walnuts may be possible.

Methods of cultivation have been undergoing a decided change in the past few years. Plows in orchards have been rapidly superseded by cover-crop disks. This has been reported as being economical where the acreage is large enough to justify the heavy equipment. It has also resulted in better soil tilth as the work has been done more nearly at the proper time. Cover-crop disks cover the acreage much more rapidly than plows.

Accompanying this change in methods has been a reduction in the amount or number of cultivations. Instead of cultivating every week or ten days the aim is to give only enough cultivation to keep down the weed growth, which at the same time maintains a light mulch. It is no longer considered necessary to have a deep dust mulch over the surface of the orchard soil.

**Cover crops.** Cover crops are used to maintain or possibly increase the fertility of the soil as well as to aid in holding the soil moisture through incorporation of organic matter in the soil.

Legumes have been favored due to their fixing of nitrogen from the air in the root nodules of the plant. Vetches have proved to be the best legumes, with spring vetch commonly used. This is planted at the rate of 20 to 40 pounds per acre accompanied by variable amounts of grain such as oats, barley, etc. The exact grain to be used depends on local conditions. If a soil has not previously grown vetch, inoculation of the seed is necessary.

The great objection to the use of vetch as a cover crop is the late growth so frequently occurring in the spring. By the time it should be plowed under the growth is not enough to justify its use. The tendency then is to allow the cover crop to grow late in the spring and thus use so much moisture that the result is more detrimental than beneficial.

Some use is being made of turnips, mustard, rape, etc., for cover crops.

Early seeding will help establish the crop so that heavy early growth in the spring may result. This early seeding is practical in young orchards but in bearing orchards the growth may be so heavy by harvest time that it interferes with harvesting. The crop is sown usually by September 15.

**Irrigation and thinning.** In any walnut orchard a time will come when the absolute limit of moisture storage and use is reached. The trees will increase in size up to the time when the demand for moisture is greater than can be supplied by the soil. There are two methods that may be used when this point is reached.

Irrigation will furnish extra moisture to the trees and maintain for a time a heavy production of good-quality nuts. The limited use of irrigation on walnuts in the Willamette Valley has been very successful. Undoubtedly more orchards could efficiently use irrigation.

With irrigation, experience in other sections shows that the trees may become too crowded and part will have to be removed. Where irrigation is not possible, and that is true of most of the walnut orchards of Oregon, removal of excess trees will be necessary whenever the moisture shortage becomes evident. This will vary with soils and locations, but many orchards are now confronted with this problem. A few growers have pulled one-half of the trees in the orchard and have been able for a time to overcome the moisture shortage in that way.

**Commercial fertilizers sometimes necessary.** The use of commercial fertilizer should be considered mainly as an adjunct or supplement to cover crops. The greatest value undoubtedly comes in directly benefiting the cover crop, and thus indirectly being of use to the walnut trees.

As to the value of a commercial fertilizer for the walnut trees themselves it has not been demonstrated, either in the plantings of the growers or by experimental work, that it is profitable. There may be soils or locations where such applications may pay but before any fertilizer is applied to the whole orchard its undoubted value should have been first proved by test plots.

Lime as a fertilizer placed directly on the orchard trees themselves has uniformly proved a failure but may in some cases be valuable in starting the cover crop, thus indirectly aiding the walnut trees.

The more the cover crop is used and the fertility increased in the soil before the walnut planting comes into bearing the better, for after the orchard is in bearing, early planting of the cover crop may not be advisable, as a rank growth may occur which will make picking up of the walnuts difficult. After an orchard once comes into bearing, seeding the cover crop may have to be delayed until later in the season.

## PRUNING AND TRAINING

**Balance the top and roots when planting.** The top of the young tree is cut back to correspond in a way to the size of the root system that remains on the tree. At the time of transplanting the trees, the root system has, in large part, been left in the nursery. After the broken ends of the roots have been pruned or smoothed up, reduction of the top must be considered. While heading back is often done for the purpose of determining the height of the head of the tree, this idea should be subordinated to that of balancing the top and the roots. If the whole top were to be left, there would be too great a leaf surface developed for the root system to furnish water and plant food.

While it is advantageous to head the trees from three to five feet in height, a certain definite height could hardly be set for all grades of trees. A tree of the eight- to ten-foot grade could be cut from three to five feet in height and partly compensate for the loss of the roots, thus establishing a partial balance. With the four- to six-foot grade, a cutting from three to five feet in height would do little toward balancing the two. Heading back should be primarily to balance the top and roots while the height of the head should be determined by later pruning. Few men head the walnut tree at the height they ultimately hope to have the head, but depend on later pruning to raise it to the desired height.

**Extreme heading back not popular.** For a time it was popularly recommended that the tree at planting time be cut at a height of from eight to sixteen inches above the ground. With this extreme cutting back but one bud was allowed to develop and the shoot from it formed the trunk of the tree. The soft, woody tissue was so easily distorted in shape by wind and other forces that it was necessary to use extra care in staking and tying. At present this method has been almost entirely discarded in favor of the higher heading as results were not commensurate with the extra labor necessary. Good, well-developed trees should, if properly handled, transplant readily and give nearly a hundred percent stand without this practice of severe cutting back.

**Watch the tree in the spring.** When the growth starts in the spring, the young tree needs to be watched carefully. With a long trunk left, it sometimes happens that every bud starts out and by fall the trunk is covered with a large number of short, weak branches. As soon as well started, the surplus, extra branches may be cut off or pinched back. Cutting is the simplest method, though by pinching back, the remaining leaves will aid in providing food for the tree. Also, the surplus buds may be rubbed off at the time of planting, but this is not as desirable as the other two methods.

What is more likely to happen is that the lower buds in the first foot or two of the trunk will start vigorously and soon outdistance the upper shoots. This may be followed by dying back of the top foot or two of the tree. Pinching back these lower branches will tend to force out the upper branches and aid the head of the tree in its development.

**Training the tree.** The training of the young tree is dependent on the shape desired, whether it should be vase-shaped or of a central-leader type. If unpruned and unheaded, the walnut tends naturally to a modified central

leader (Figure 10), but under cultural conditions this is often difficult to obtain. The vase-shaped tree is the easiest to form, but it is the weakest type of tree. With all the main branches coming from within a very short distance on the trunk (Figure 11) all of the weight and stress is centered there, often resulting in the breaking or splitting down of the trunk.

For strength in the tree, the central leader is the better shape to train to. The top bud on the trunk of the small tree if well matured will usually continue the upright growth of the trunk. If too many laterals are allowed to come out at one point, as often happens near the upper part, the central leader wll be choked out (Figure 12). The strength of the central-leader type of tree lies mainly in the distribution of the weight of the branches over a considerable part of the trunk.

Figure 10. Central leader in a tree that had never been pruned.

In the desire to obtain high-headed trees, at times it is the practice to strip off the lower limbs, leaving none but the central leader. This is continued for one or more seasons, ultimately branching the trees at a height of six or more feet. This practice seems to cause a starvation of the

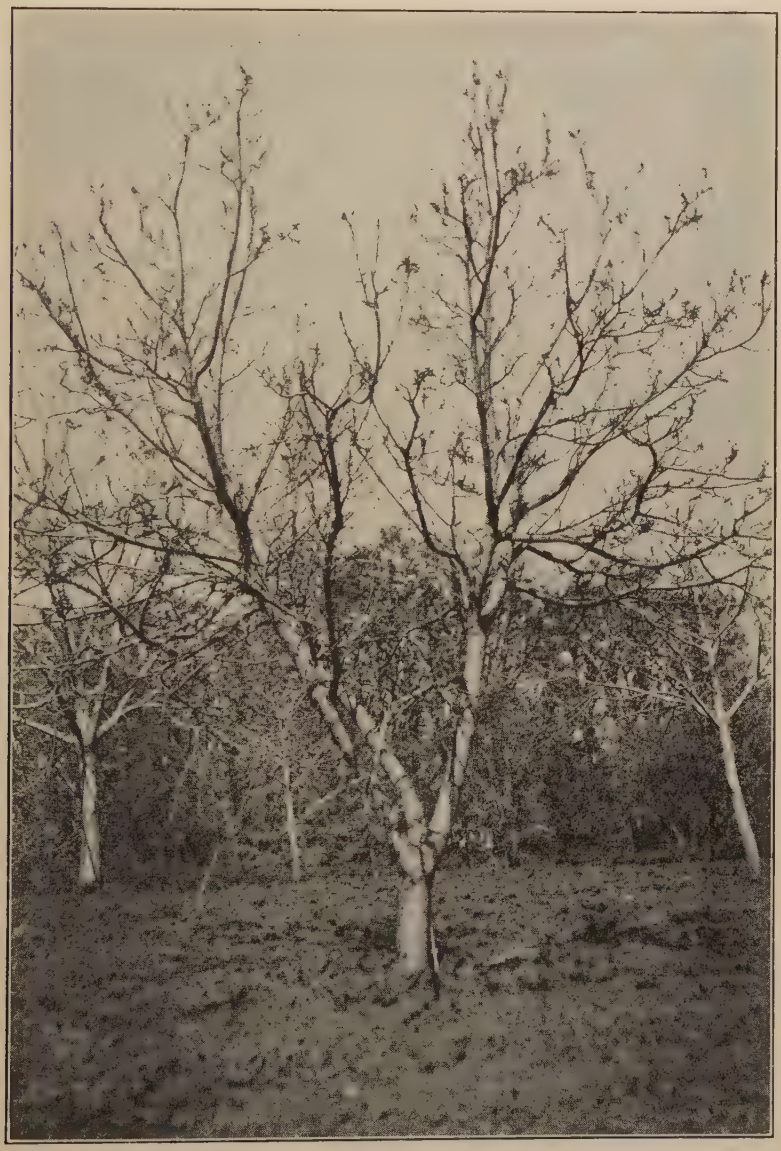

Figure 11. Very common form of branching but very weak.

tree. If such a high-headed tree is desired, it may be obtained more quickly by allowing the lower limbs to grow. The leaves on these lower limbs help feed the tree, and greater strength is thus obtained in the upper part of the tree, resulting in a better growth of the upper limbs. These lower limbs

Figure 12. Showing how a central leader may be choked by lateral limbs coming out at one point on the trunk.

may be pruned off in a year or two without any great loss to the tree. Extreme cases have been known where the laterals were kept stripped off for a period of three or four years, resulting in very slow terminal growth each year, simply because of starvation. Unless sufficient leaf surface is allowed on the tree, little growth can be expected.

These lower limbs will also serve another useful purpose. The walnut varieties grown here have a tendency to a drooping habit. The lower, new shoots will naturally droop toward the ground if unobstructed. The lower limbs, if allowed to remain, will aid in getting a more upright growth by forcing the new growth in an upright direction.

It may not be possible to obtain all the scaffold branches the first year, but in most cases these can be properly spaced by the end of the second year. Too many should not be left, but they should be widely spaced. As the leader continues more will generally be added, but these will space themselves more nearly in the natural way that the trees normally grow. This first year or two is the most difficult period in the training of the tree. Later training will be very easy with a relatively light amount of work. The greatest need will be to keep the framework thinned down. Since the walnut makes a much larger tree than most other fruit trees, the initial spacing of the limbs should be much greater.

**Later pruning.** This will consist mainly in keeping the top thinned out. As the top of the tree thickens up, the fruits borne on the inside will decrease in number and become small, poorly filled nuts. Thinning out the top will better maintain the bearing wood throughout the whole tree by letting in the light, thus giving greater surface for bearing than if thinning were restricted only to the outer part.

Cutting away the under-drooping limbs may be desirable to enable cultivation to be carried on. Thinning and other pruning practices should be an annual affair, as this will prevent the necessity for large cuts as is the case when the pruning is done only occasionally.

**Reinvigorating the old trees.** Many of the older trees are entirely too dense and have only a small bearing surface for the size of the tree. The growth of the new wood is so weak and short that healthy, vigorous buds are not formed. Many of these plantings need to have a number of the trees removed, and they also need thinning out by pruning the individual trees. This thinning out, accompanied by a good cultivation program, will invigorate the trees, stimulate them into renewed growth, and in time bring the trees into heavier bearing.

**Staking the tree.** In the rapid growth made by the walnut trees, the wood is frequently too soft to withstand the wind, especially if the wind comes continually and mainly from one direction during the growing season. The trees often lean decidedly away from the wind instead of maintaining an unright position. This necessitates staking young trees for a few years.

The stake is from seven to nine feet in height, set to the windward side of the tree, and from six to eight inches from the tree. If leaned slightly away from the tree, the stake will be more likely to maintain the tree in an upright position.

Tying the stake to the tree can be done with almost any kind of material, but the difficulty is in obtaining something that will last more than one season, and not chafe the bark. One of the best ties developed is made of baling wire. Three wires are used wrapped in burlap.[4] The wires and burlap are placed on the side of the tree opposite the stake, then brought back of the tree and the wires crossed. After crossing, the wires are led around the stake to the back, where they are tied together and held from sliding down by a nail driven into the post.

Particular care is necessary to avoid tying too tightly. The walnut grows rapidly, and unless plenty of space is left for the tree to develop, the tree will be choked and girdled.

## TOP-WORKING

**Worthless seedlings need top-working.** In every seedling orchard a certain percentage of the trees on coming into bearing are found to be unsatisfactory for one reason or another. If individual records of the trees are kept, those unsatisfactory trees can be definitely located so that they may be grafted over and not kept as boarders in the orchard. Records should be kept as to the time of leafing out, the amount of blight, the crop, and the kinds of nuts produced. Some of these data, such as the amount of crop, need not be absolutely accurate but if recorded as a relative amount for several years, it will be possible to locate the poor trees and top-work them with some standard variety or to one of the better seedlings.

The principles of top-working are practically the same as applied to other trees. With old trees it is not the best practice to top-work the whole tree at once. If all the scions take, it is well, but if the large part fail, as often happens, the work and time necessary to finish top-working later is very great. Grafting one-third or one-half of a large tree at a time allows the tree, in a measure, to manufacture plant food and does not permit the root system to starve out. Where the whole tree is worked over there is little chance for elaboration of plant food until late in the summer with but a small amount of food furnished to the root system. Many trees have been found badly devitalized and a few have died from the effects of attempting to work over the whole tree at one time.

**Small cuts best.** The latest recommendation is to make small cuts in top-working trees—usually not to exceed 2½ to 3 inches. This size heals over readily, in contrast to the larger wounds. The use of small cuts greatly increases the cost of working over trees since many more scions will have to be set in each tree. When a person can do the work himself the cost is not so important, but when the work is paid for at so much a scion the cost amounts to a considerable sum of money.

The modified cleft is commonly used and is claimed to be the strongest form of graft. It is often objected to on the ground that the opening of the cleft provides easy entrance for heart-rot. Especially is this so if the cuts are very large.

Inlay and some form of bark grafts are used by some in top-working trees, but they are open to the same objections held to bark grafts with other fruit trees. The scion is not held so firmly and the union is such that

the growth is more likely to break off than in the cleft graft. These kinds are said to take more readily than the cleft graft.

Top-working is most successfully performed about the time the buds are opening or a little later. The professional grafters work long before and long after this time. Scions have been made to grow when set as early as January 1 and as late as July 4.

The scions are enclosed in paper sacks for protection of the young growth just after starting, the sacks being torn open as growth develops. Provision must be made for support of the new growth. Supports of 1″ x 1″, or 1″ x 2″ lumber, are nailed to the stubs and the new growth is tied to the support. If this is not done the new growths often assume fantastic shapes, seldom continuing in the direction of the limbs.

Figure 13. A "sleeper" partly grafted over.

**Some "sleepers" are doubtful.** One kind of useless tree that should be eliminated from the orchard is the "sleeper." This kind of tree does not come into leaf until very late, sometimes not until in July (Figure 13). Such trees do not have a growing season long enough to mature a crop. When another variety is grafted on to these trees they sometimes prove unsatisfactory. The earliest of the sleepers will produce fair crops. The later the original top of the sleeper comes out before the grafting is done, the later the new top will make the season's growth after a first opening of the buds. As a result but a small growth is made each year. This makes a very small tree with but a limited potential bearing capacity even though it may bear heavily for the size of tree. The sleepy roots apparently will not begin functioning properly until just about the same time each year, regardless of the top grafted on to it. Only the earlier ones are profitably worked over, while the later ones can be replaced by new trees.

Apparently the very early trees can be top-worked, as the earliness of the roots influences the top but a minimum amount. These are more likely to be satisfactory when top-worked than are the very late ones.

**Utility and decorative value combined.** Many large, old, black walnut trees are found in the state and many of these are being worked over to the English walnuts. While the landscape architect may not approve of this, as the black walnut is considered superior to the English walnut for decorative effect in landscape use, the income from such trees tempts many people to top-work the trees. When properly grafted the yields obtained from such trees are in some instances large.

## HARVESTING

**Pick up and wash the nuts promptly.** The essential feature of good harvesting of walnuts in Oregon is found in prompt picking and drying. During the average season more or less rain occurs, with a consequent staining and molding of the nuts unless they are properly handled at short intervals. Nuts should not be allowed to lie on the ground for any length of time. Molds will develop or stains occur that will reduce the grade of the nuts. Even though no evidence is visible on the outer side of the shell, molds will at times be noticed growing on the kernel.

Shaking of the tree is advisable as a regular practice. Often the hulls will partly open up but not sufficiently to allow the nuts to drop out. Such nuts will soon develop molds. Long poles with hooks are regularly used and should be employed from the first picking.

Under Oregon climatic conditions, so few of the nuts are clean enough without washing that washing is employed on the whole crop. Many kinds of washers are on the market but all of them use the principle of brushing or scrubbing with a mat or brush, working in water, either running water or in a bath. By this means the dust and foreign materials are removed from the shell, though discoloration from blight, molds, or similar causes cannot be eliminated.

**Dry promptly after washing.** After picking, the nuts are put into sacks or boxes and moved promptly through the washer to the drier. Delay will result in lowering the quality of the nuts. It is better to allow them to lie on the ground rather than to stand in the sack.

**Moderate temperature used in drying.** Since climatic conditions preclude the possibility of drying by the sun, walnuts are dried by artificial means. Temperatures of 90° to 105° F. at the point of first contact with the nuts give the best results. Higher temperatures may result in freeing the oil in the kernel, giving a rancid meat within a very short time, and may also crack the shells by too rapid drying. Temperatures below 90° F. allow slow drying with the danger of mold. Prompt, quick drying gives the best quality of meat.

Walnuts may be considered as dry when the meat or the dividing membrane is brittle enough to snap with a distinct, sharp, snapping break. If the membrane and kernel bend considerably before breaking, more drying is necessary. Some growers test by biting the meat, which is essentially the same as the former test. Walnuts can be easily overdried, but if allowed to stand under ordinary storage conditions they will quickly absorb an additional amount of moisture. The shell is very porous and allows the ready transfer of moisture to the kernel.

**Several types of driers in use.** Probably more walnuts are dried in the prune driers, or in the Oregon tunnel driers, than in any other form of drier. This is owing to the fact that such driers are commonly present on the ranches and it is not desirable to build another drier especially and solely for walnuts. These driers are fairly satisfactory, but owing to the low temperature necessary in the drying of walnuts the natural-draft type is very slow. The circulation of the air is very slow, as there is not enough difference in the temperature in the tunnel and the outside to promote a rapid movement of the air, so that little moisture is carried off, and that but very slowly. Where provided with fans for recirculation this type is capable of producing dry walnuts in a relatively short time.

The kiln type such as is used for hops has proved somewhat more satisfactory, being a little quicker in drying, and also somewhat cheaper in operation. Few of these are being built, however, as the orchards are seldom large enough to have an acreage sufficient to warrant the expenditure necessary when the tunnel type of drier is so commonly found in the neighborhood.

If a drier is to be built especially for walnuts, the recirculation type as developed by the Oregon Agricultural Experiment Station is very satisfactory.[5] In this way the walnuts are dried in the shortest length of time and at the least cost. The saving in cost is in part owing to the fact that the walnuts can be piled in the bins three feet deep and air circulated through them. This does away with the expense of trays and handling as when single layers are used.

In recirculation, whether applied to the tunnel driers, or to the bin driers, the time is much shorter than with the natural-draft type of drier. The film of water vapor forming around the nuts following evaporation is broken up and carried away so that the movement of the moisture from the kernels and shell is faster.

The natural-draft tunnel drier requires from 48 to 72 hours to complete drying, and only occasionally can the nuts be dried in the shorter time mentioned. The kiln driers require somewhat less time. The recirculation driers dry in from 20 to 40 hours, and the recirculated bin drier is much more efficient than the recirculation tunnel dryer. Drying costs vary from $5.50 to $20.00 per ton, depending on the drier, weather, etc.

**Bleaching of walnuts.** Oregon walnuts were formerly marketed in an unbleached condition, but the demand of the trade has led to the general practice of bleaching. Some walnuts are still sold in an unbleached condition, but most of those destined for out-of-state markets must be bleached.

Bleaching as carried on in some of the larger plants of the state is discussed in Station Bulletin 227. Full directions are given for the preparation of the material and the operation of the plan.

Since the season of 1928 several growers have been using a simpler method with success. This was especially suited to the grower who was handling and marketing small quantities, although it can be adapted to larger quantities.

The materials used are as follows:[6]

| | |
|---|---|
| Commercial chlorine bleach | 2½ gallons |
| Water | 35 gallons |
| Sulfuric acid | 3 ounces |

The sulfuric acid is mixed with 2½ gallons of water and left in a glass or stoneware receptacle. The bleaching solution and the acid are not mixed until ready to be used.

The equipment consists of two tanks, barrels, or other containers, with a drain board carrying back to the first container. The drain board may be built as a regular drain board or third tank, leading to the first one. In the first tank put the bleaching solution composed of the above mixture. The walnuts are put in some sort of closed basket and immersed from two to three minutes, as needed, to get the desired bleach. They are then placed on the drain board for two minutes and then dipped in the last receptacle, which should contain clean water. After this their shells are slowly dried by again being run through the dryer for about twelve hours. The nuts are then dried at a low heat and rather slowly.

**Grading the walnuts.** Grades for walnuts are in a more or less formative stage. Different agencies, including the United States Department of Agriculture, are studying the needs, and doubtless in the future a general standard grade will be adopted for the walnut industry. A general standard is needed to help stabilize the whole industry. Regardless of the size of the nut, great care should be taken in maintaining strict grades. The inferior grades should be cracked and the meats disposed of in cracked form.

Before going over the grader the walnuts are often passed through a suction machine where the blank nuts or the partly filled nuts are taken out. The usual guarantee is that at least 90 percent of the nuts will give a good cracking test, though some growers will guarantee a 95 per cent cracking test and still comply with the grades under which they are listed so far as other qualities are concerned.

Several types of graders are on the market, costing from $400 to $500 or even $2,500 per machine, and most of the types are doing good work. In general, these have either revolving drums, rotating bars, or stationary bars for the sizing of the nuts. Some have a much greater capacity than others.

The walnuts are sacked in 50- and 100-pound sacks, for the most part, though an increasing volume is being put up in 5- and 10-pound sacks which may be delivered unopened to the consumer.

The rules or grades are promulgated by associations of growers, part of whom sell through a central cooperative office. These cooperative associations have locals scattered throughout the district where the nuts may or may not be graded and packed. Those not belonging to the cooperative associations sell to the local firms or stores, only a small quantity of nuts being handled by any shipping firms.

## AGE OF BEARING

Walnut trees are slow in coming into bearing as compared with many fruit trees. From the commercial point of view, they cannot be expected to return a profit until the ninth to the eleventh year. This is the profit after cultivation costs have been deducted and a reasonable allowance made for overhead charges.

Trees occasionally bear nuts at from three to five years of age, but the yield per acre is very small. The production of a few nuts per tree must not be confused with a profit-making crop of reasonable tonnage.

The data as to yields per acre for different ages of plantings and the cost of producing walnuts will be available in another publication.

## THE WALNUT AS AN ORNAMENTAL TREE

In the endeavor to combine beauty and utility many people are planting the English walnut as an ornamental tree. With a crop of nuts it is the expectation that a cash return will be added to the enjoyment derived from the tree as an ornamental plant. Walnut trees for street planting cannot be recommended when it is considered that the soil, drainage, and frost-protection factors are so exacting. The same requirements are to be satisfied in dooryard planting as in a commercial planting. Unless the trees are provided for they will not develop symmetrically and fully.

With the proper conditions the walnut tree has a natural characteristic of large growth, and in small spaces will crowd and overshadow everything else of a smaller type. In large grounds, such as parks or the grounds of the average farm home where large spaces are available, it certainly has a valuable place. One or more trees may be planted profitably if the soil condition or other factors are suitable. On the small city lot, one walnut tree will in time dominate the whole lot.

On large grounds, such as golf courses and parks, the walnuts may be objectionable from the standpoint of the large amount of debris shed each year in the form of leaves, shucks, and nuts. This debris is particularly a disadvantage in the use of the walnut tree on any street, while the contest between small boys and the owner of a street tree for the crop of nuts will be found to be a bitter one.

As a street tree also it has the objectionable features of the drooping habit which necessitates continual pruning to keep the lower limbs out of the way of passers-by; this, combined with the large size and debris scattered by the tree, causes it to be held in disfavor by the landscape specialists.

## INSECTS ATTACKING WALNUTS

Up to the present time insect pests have been of minor importance in walnut culture in Oregon. A few are present each year, and some years one or two of the insects become somewhat prevalent. As yet no general spray program against insects is necessary.

**Codling-moth** (*Carpocapsa pomonella*). This insect has been known for years as attacking walnuts in Oregon, but so far has been found mostly in dooryard trees and in the cities. It quite evidently is the same insect that attacks the apple, though only recently has it been found on the walnut. In many cases apples have been grown adjacent to walnut orchards for years and no infection of the walnuts has been found. Whether this will spread or not is a matter to be watched carefully. The insect feeds on the kernel, destroying it in part, thus rendering the nut uneatable.

In California, where it is necessary to spray for codling-moth, the recommendations are 5 pounds of lead arsenate to 100 gallons of water, which is much stronger than the average spray for the codling-moth on the apple. Large, powerful outfits equipped with spray guns are necessary to cover the larger trees. Where they can be used the liquid sprays have been found more satisfactory than the dust sprays.

**Aphis** (*Chromaphis juglandicola*). These insects show up occasionally in considerable numbers, and in most seasons at least few can be found. In California it is reported that attacks of aphids are responsible for lighter crops of small, light nuts with imperfect shells. This is a small, green aphis that causes the sticky honeydew occasionally found on the trees. This soon turns black and gives the dirty, greasy look often found on walnuts. If thought necessary to spray for the aphids 40 per cent nicotine sulfate at the usual rate may be used. Also, 2 per cent nicotine dust may be used against the insect. Neither one has been necessary as a rule in this state, though some growers have sprayed or dusted at times of heavy infestation.

**Erinose mite** (*Eriophytes tritriatus*). This mite works within the leaves, causing a swelling on the upper surface and a pocketing or depression on the lower surface. This pocket is covered on the under surface with a white, felt-like growth.

The insect apparently is wide-spread, but of no economic importance, as no serious injury has been reported to the trees. It seems that certain trees are more affected than others, but even with these heavily infested trees no necessity of spraying has been encountered.

**Red spider** (*Tetranychus bimaculatus*). This insect also appears in some seasons but rarely in such numbers as to affect the vitality of the trees. The control of this insect is discussed in a separate circular on the control of red spider. This insect seldom appears in such numbers as even to attract attention.

**The Eureopean walnut aphis** (*Callipterus juglandis* Frisch.*), new to Oregon and not heretofore taken in this state was discovered in 1927 by the Entomology department as doing serious damage to walnuts. This aphis is many times as large as the common walnut aphis and works entirely on the upper surface of the leaves along the mid-rib. Nothing is known of its life habits, but field observations indicate that careful application of a 2-per-cent nicotine dust will control the aphis.

## DISEASES AFFECTING WALNUTS

**Walnut blight** (*Pseudomonas juglandis*). This bacterial disease causes greater loss than any other disease or insect, and probably more loss than all insects and fungous agencies combined. It is very noticeable on the leaves, where it causes small, black, angular spots, often running together into large black patches. An early attack of the blight will cause the nuts to turn black and drop off the trees. Later infection will cause black spots on the husks, though the entire kernel may be blackened and destroyed.

*Determined by Dr. P. W. Mason, United States Bureau of Entomology.

These internally blighted nuts usually fall some time before the regular crop is harvested, and can be eliminated from the regular pick-up if rolled into the ground or picked up before the regular picking occurs. The latest infections may affect only the outer husk, holding it tight to the shell, or turning the shell black in spots. In seasons favorable to the spread of blight, 40 to 50 per cent of the crop may be destroyed. The tender twig growth of the trees may also be attacked and stunted.

This disease is more prevalent during rainy seasons than during dry seasons. The causal bacteria are evidently spread by several agencies, such as insects, rain, etc.

Full details as to the control methods for walnut blight will soon be available in a separate publication.

**Mushroom root-rot** (*Armillaria méllea*). This disease is known to attack the English walnut on its own roots. By destroying the bark of the roots the root system is girdled, killing the tree. This fungus is likely to be found on recently cleared land, especially if cleared of the native oak.

If the bark killing has not gone too far, trees infected by the fungus can be helped by opening up the soil around the roots and exposing the soil to the sunlight. This means that a considerable quantity of soil will have to be removed from around the roots of the trees, leaving a large hole, according to the size of the tree. The affected part should be cut away down to the wood, and the wound covered with bordeaux paste to prevent later infection by heart-rot. Then the source of infection in the soil should be located and removed. There are likely to be some partly rotted roots or stumps remaining in the soil after clearing. The pieces of roots harboring the fungus may remain in the soil for years before infection occurs on the trees.

The best preventive measure, and the only real solution for this trouble, is the use of black walnut stock, which is practically immune to attack of the fungus. Trees grafted on black walnuts should not be planted so deeply that the soil comes above the graft union, as the fungus can attack the English walnut wood and girdle the tree above the graft. From observations, it is apparently safe to plant the walnuts on land infected with mushroom-rot provided the black walnut stock is used.

**Crown-gall** (*Bacterium tumefaciens*). This disease is found occasionally, but not to any serious extent. Large swellings are found on the roots just at or below the surface of the ground. The swellings later decay, thus offering entrance to decay fungi, and at the same time tending to girdle the tree, thus cutting off the food supply. Few trees die from this trouble outright, although some are definitely stunted and rendered valueless for production. The best preventive is thorough inspection of the nursery stock before the trees are planted in the field.

**Die-back or winter injury.** This cannot be listed strictly as a disease, but is more commonly caused by adverse soil or climatic conditions. Diseases of the wood may be contributing factors by weakening the tree, but they are not the usual direct causes.

The most common condition causing die-back is wet soil. Trees growing under these conditions often have a normal season's growth but die

back during the following spring or summer. The dying back may be uniform over the whole tree, or may more severely affect one part of the tree than another. There is no remedy for such conditions except to avoid planting in locations where high water-table will be present during a part of the year.

An early fall frost coming before the wood is hardened and mature will cause similar results. Reports have been received of young trees being completely killed by such early fall frosts. Late cultivation in the summer, which keeps the young trees growing until late fall, will contribute to the tenderness of the tree and add to the susceptibility to frost. With average cultivation, the young trees can be kept growing until the late summer, while excessive cultivation may force tree growth along too rapidly and too late in the fall. Very severe winter temperatures will also cause the one-year-old growth to die back or show a dead condition at the beginning of the following season.

After trees have been badly winter injured, they may show a general decline a few years later, associated with some die-back. This is probably owing to the increased ravages of wood-rotting fungi that are decreasing the food- and water-transporting facilities of the tree. Such trees are usually so badly injured that little or nothing can be done for them.

On the whole, the best measures to prevent die-back or winter-kill are so to locate the orchards that they will not be subject to adverse soil conditions or to danger from frost. The form of die-back commonly reported from California districts, which is drying out of the soil accompanied by injury to the tree during the winter time, is not a factor in this country, but the other causes must be carefully considered to avoid the die-back frequently found in many of our orchards.

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